

AMENDMENTS TO THE CLAIMS

1. (currently amended) An image processing apparatus for processing image data including a plurality of pixels each of which has level data, said image processing apparatus comprising:

gradient calculation means for calculating at least a direction of the level gradient of each of a plurality of processing units in ~~a given image data including a plurality of pixels, the pixels respectively having level data~~ said image data to be processed;

line segment formation means for producing a line segment image, which is distinguished from an image represented by said image data, by forming a plurality of line segments each of which comprises a plurality of pixels and has a line segment length L and a direction corresponding to the direction of the level gradient ~~data representing a line segment which comprises a plurality of pixels for each of the plurality of processing units, the line segment formation means including means for setting a line segment length L, the line segment formation means being arranged and configured to form line segments having said length L, and a direction corresponding to the direction of each level gradient which is calculated by said gradient calculation means, the line segment formation means including means for setting said length L;~~ and

a line segment image storage means for storing the line segment image ~~data~~ produced by said line segment formation means.

2. (original) The image processing apparatus according to claim 1, further comprising image storage means for storing said given image data.

3. (previously presented) The image processing apparatus according to claim 1, further comprising image data extraction means for extracting image data in a processing region set in input image data and feeding the extracted image data to said gradient calculation means.

4. (original) The image processing apparatus according to claim 3, further comprising means for setting said processing region.

5. (currently amended) The image processing apparatus according to claim 1, wherein said line segment formation means produces line segment image ~~data~~ at a gray level.

6. (currently amended) The image processing apparatus according to claim 1, wherein said line segment formation means produces line segment image ~~data~~ at a binary level.

7. (currently amended) The image processing apparatus according to claim 1, wherein said gradient calculation means calculates a ~~the~~ magnitude of the level gradient in addition to the direction of the level gradient.

8. (currently amended) The image processing apparatus according to claim 1, wherein said gradient calculation means calculates a ~~the~~ magnitude of the level gradient in addition to the direction of the level gradient, and

said line segment formation means produces said line segment image ~~data~~ having a level corresponding to the magnitude of the level gradient which is calculated by said gradient calculation means.

9. (currently amended) The image processing apparatus according to claim 1, wherein said gradient calculation means calculates a ~~the~~ magnitude of the level gradient in addition to the direction of the level gradient, and

said line segment formation means produces said line segment image ~~data~~ only when the magnitude of the level gradient which is calculated by said gradient calculation means is not less than a predetermined threshold.

10. (currently amended) The image processing apparatus according to claim 1, wherein said line segment image storage means adds new line segment image ~~data~~ to line segment image ~~data~~ already stored at each of the pixels, and stores the result of the addition.

11. (currently amended) The image processing apparatus according to claim 1, wherein said line segment image storage means stores new line segment image ~~data~~ without subjecting the line segment image ~~data~~ to addition processing.

12. (previously presented) The image processing apparatus according to claim 1, wherein said line segment formation means produces a line segment having line segment length L in a direction corresponding to the calculated direction of the level gradient from the position of the processing unit.

13. (currently amended) The image processing apparatus according to claim 1, wherein said line segment formation means produces, when a ~~the~~ distance from a ~~the~~ position of the processing unit to an initial point and a ~~the~~ distance from the processing unit to a terminal point are specified, a line segment from said initial point to said terminal point in a direction corresponding to the calculated direction of the level gradient.

14. (original) The image processing apparatus according to claim 12, further comprising means for setting the length of the line segment.

15. (original) The image processing apparatus according to claim 13, further comprising means for setting at least one of the distance from the processing unit to the initial point and the distance from the processing unit to the terminal point.

16. (currently amended) The image processing apparatus according to claim 1, further comprising means for detecting a portion of the given image data to be processed where line segments represented by the line segment image ~~data~~ stored in said line segment image storage means are concentrated.

17. (currently amended) The image processing apparatus according to claim 1, further comprising means for detecting the position of the pixel having the maximum of the levels of the line segment image ~~data~~ stored in said line segment image storing means.

18. (original) The image processing apparatus according to claim 17, further comprising means for judging whether or not said maximum level exceeds a predetermined threshold.

19. (previously presented) The image processing apparatus according to claim 1, further comprising image input means having a camera for producing image data and feeding the produced image data to said gradient calculation means.

20. (currently amended) The image processing apparatus according to claim 1, further comprising a display device for displaying a line segment image represented by the line segment image ~~data~~ produced by said line segment formation means or the line segment image ~~data~~ stored in said line segment image storage means.

21. (currently amended) The image processing apparatus according to claim 20, wherein said display device displays an image represented by said given image data with the image overlapped with said line segment image.

22. (currently amended) The image processing apparatus according to claim 20 further comprising means for extracting an edge of the image represented by said given image data to be processed, said display device displaying an image represented by the extracted edge with the image overlapped with said line segment image.

23. (original) The image processing apparatus according to claim 16, further comprising a display device for displaying a mark representing the portion, where the line segments are concentrated, detected by said detection means with the mark overlapped with the image represented by said image data.

24. (original) The image processing apparatus according to claim 17, further comprising a display device for displaying, at the position of the pixel having the maximum level which is detected by said detection means, a mark indicating that the pixel has the maximum level with the mark overlapped with the image represented by said image data.

25. (original) The image processing apparatus according to claim 18, further comprising a display device for displaying, at the position of a pixel having the maximum level which is judged to exceed a threshold by said judgment means, a mark indicating that the pixel has the maximum level with the mark overlapped with the image represented by said image data.

26. (previously presented) The image processing apparatus according to claim 23, further comprising means for extracting an edge of the image represented by said image data, said display device displaying an image represented by the edge extracted by said edge extraction means in addition to or in place of the image represented by said image data.

27. (currently amended) The image processing apparatus according to claim 26, wherein said display device displays the line segment image ~~represented by said line segment image data~~ with the line segment image further overlapped with the image represented by the edge.

28. (currently amended) An image processing apparatus for processing an image data including a plurality of pixels each of which has level data, said image processing apparatus comprising:

an image processing means for calculating at least the direction of the level gradient of each of a plurality of processing units in given image data, and producing line segment ~~data~~ image which is distinguished from an image represented from said image data including ~~representing~~ a line segment which comprises a plurality of pixels for each of the plurality of processing units, said image processing means including means for predetermining a line segment length L, the image processing means being arranged and configured to form line segments having said predetermined length L and a direction corresponding to the calculated direction of the level gradient for each image ~~data~~ having a non-zero level gradient; and

display means for displaying the line segment images ~~represented by the line segment image data~~ produced by said image processing means.

29. (currently amended) The image processing apparatus according to claim 28, wherein said display ~~device~~ means displays the image represented by said image data with the image overlapped with said line segment image.

30. (currently amended) The image processing apparatus according to claim 29, further comprising means for extracting an edge of the image ~~represented by said image data~~, said

display ~~device~~ means displaying an image represented by the edge extracted by said edge extraction means in addition to or in place of the image ~~represented by said image data~~.

31. (currently amended) An image processing method for processing an image data including a plurality of pixels each of which has level data, said image processing method comprising the steps of:

calculating at least the direction of the level gradient of each of a plurality of processing units in given image data including a plurality of pixels, the pixels respectively having level data;

providing a predetermined line segment length;

producing line segment image which is distinguished from an image represented by said image data representing a line segment which comprises a plurality of pixels for each of the plurality of processing units, each line segment having said predetermined line segment length and a direction corresponding to the calculated direction of the level gradient for each pixel having a non-zero level gradient; and

storing the produced line segment image ~~data~~ in storage means.

32. (currently amended) A medium storing a program for controlling a computer to process an image data including a plurality of pixels each of which has level data, so as to:

calculate at least the direction of the level gradient of each of a plurality of processing units in given image data including a plurality of pixels, the pixels respectively having level data;

provide a predetermined line segment length;

produce line segment image which is distinguished from an image represented by said image data representing a line segment which comprises a plurality of pixels for each of the plurality of processing units, each line segment having said predetermined line segment length and a direction corresponding to the calculated direction of the level gradient for each pixel having a non-zero level gradient; and

store the produced line segment image ~~data~~ in storage means.

33. (currently amended) An image processing method for processing an image data including a plurality of pixels each of which has level data, said image processing method comprising:

calculating at least the direction of the level gradient of each of a plurality of processing units in given image data;

providing a predetermined line segment length;

producing line segment image which is distinguished from an image represented by said image data representing a line segment which comprises a plurality of pixels for each of the plurality of processing units, each line segment having said predetermined line segment length and a direction corresponding to the calculated direction of the level gradient for each image ~~data~~ having a non-zero level gradient; and

displaying line segment images represented by the produced line segment image ~~data~~ on a display device.

34. (currently amended) A medium storing a program for controlling a computer to process an image data including a plurality of pixels each of which has level data, so as to:

calculate at least the direction of the level gradient for each of a plurality of processing units in given image data,

provide a predetermined line segment length, and

produce line segment image which is distinguished from an image represented by said image data representing a line segment which comprises a plurality of pixels for each of the plurality of processing units, each line segment having said predetermined line segment length and a direction corresponding to the calculated direction of the level gradient for each processing unit having a non-zero level gradient; and

display line segment images represented by the produced line segment image ~~data~~ on a display device.

35. (currently amended) An image processing apparatus for processing an image data including a plurality of pixels each of which has level data, said image processing apparatus comprising:

means for extracting a plurality of edges whose level gradients are not less than a predetermined value in said given image data;

means for providing a predetermined line segment length;

means for setting, for each of the edges, a line segment which comprises a plurality of pixels extending said predetermined length in a direction corresponding to the direction of the extracted edge; and

means for detecting the presence or absence of a point of intersection of a plurality of line segments and the position thereof.

36. (original) The image processing apparatus according to claim 35, wherein the direction of the line segment is a direction perpendicular to the direction of the edge or the same direction as the direction of the edge.

37. (currently amended) An inspection apparatus comprising:

image input means for inputting image data representing an inspection object;

means for specifying a line segment length;

means for calculating at least the direction of the level gradient of each of a plurality of processing units in said input image data, and producing line segment image data representing a line segment which comprises a plurality of pixels for each of the plurality of processing units, each line segment having said specified line segment length and a direction corresponding to the calculated direction of the level gradient; and

means for detecting the presence or absence of a portion where the line segments are concentrated or are overlapped with one another and the position thereof on the basis of the produced line segment image data.

38. (original) The inspection apparatus according to claim 37, wherein the direction corresponding to the direction of said level gradient is the direction of the level gradient or a direction perpendicular to the direction of the level gradient.

39. (currently amended) The inspection apparatus according to claim 38, further comprising a display device for displaying the line segment image on the basis of said line segment image data.

40. (original) The inspection apparatus according to claim 39, wherein said display device displays an image of the object represented by said input image data with the image overlapped with the line segment image.

41. (previously presented) The inspection apparatus according to claim 37, further comprising a display device for displaying the detected position of the portion where the line segment images are concentrated or are overlapped with one another on the image of the object represented by said input image data or an image represented by an edge extracted from said input image data.

42. (currently amended) The inspection apparatus according to claim 37, further comprising means for inputting data relating to the length of the line segment or an ~~the~~ initial point and a ~~the~~ terminal point of the line segment.

Claims 43-47 (canceled).

48. (currently amended) An image processing apparatus for processing an image data including a plurality of pixels each of which has level data, said image processing apparatus comprising:

a gradient calculator which calculates at least the direction of the level gradient of a processing unit in a given image data including a plurality of pixels, the pixels respectively having level data;

a line segment length provider which provides a line segment length;

a line segment former which produces line segment image ~~data~~ representing a line segment which comprises a plurality of pixels having said line segment length and a direction corresponding to the direction of the level gradient which is calculated by said gradient calculation means; and

line segment image storage which stores the line segment image ~~data~~ produced by said line segment formation means.

49. (previously presented) The image processing apparatus according to claim 8, further comprising means for detecting a level value of the line segment image data for each of the plurality of processing units in the given image.

50. (previously presented) The image processing apparatus according to claim 49, further comprising means for determining a concentration of level values in a processing region.

51. (currently amended) The image processing method according to claim 31, further comprising

calculating a magnitude of the level gradient of each of the plurality of processing units in the given image data; and

producing the line segment image ~~data~~ to include a level value corresponding to the magnitude of the level gradient.

52. (currently amended) The image processing method of claim 51, further comprising detecting a level value of the line segment image ~~data~~ for each of the plurality of processing units in the given image.

53. (previously presented) The image processing method according to claim 52, further comprising determining a concentration of level values in a processing region.

54. (currently amended) The inspection apparatus of claim 37, wherein the means for calculating determines a magnitude of the level gradient of each of the plurality of processing units, and produces line segment ~~data~~ image including level values corresponding to respective magnitudes of the level gradient.

55. (previously presented) The inspection apparatus of claim 54, wherein the means for detecting recognizes coordinates for all processing units on each line segment and calculates a level value held by processing units in a processing region.

56. (currently amended) An image processing apparatus for processing an image data including a plurality of pixels each of which has level data, said image processing apparatus comprising:

gradient calculation means for calculating at least the direction of the level gradient of each of a plurality of processing units in given image data including a plurality of pixels, the pixels respectively having level data;

line segment formation means for producing line segment image ~~data~~ representing a line segment which comprises a plurality of pixels for each of the plurality of processing units, the line segment formation means being arranged and configured to form line segments each having a respective given length L, and a direction corresponding respectively to the direction of each level gradient which is calculated by said gradient calculation means;

means for varying the given length L prior to forming said line segments; and

line segment image storage means for storing the line segment image ~~data~~ produced by said line segment formation means.

57. (currently amended) An image processing apparatus for processing an image data including a plurality of pixels each of which has level data, said image processing apparatus comprising:

gradient calculation means for calculating at least the direction of the level gradient of each of a plurality of processing units in given image data including a plurality of pixels, the pixels respectively having level data;

line segment formation means for producing line segment image ~~data~~ representing a line segment which comprises a plurality of pixels for each of the plurality of processing units, each line segment having a given length and a direction corresponding respectively to the direction of each level gradient which is calculated by said gradient calculation means; and

line segment image storage means arranged and configured to store, for each respective pixel through which the line segment passes, the line segment image ~~data~~ produced by said line segment formation means at said respective pixel.

58. (currently amended) The image processing apparatus of claim 57 wherein the line segment image ~~data~~ includes a level, and the data stored includes a respective line segment level for at least one line segment passing through a respective pixel.

59. (currently amended) An apparatus configured and arranged to perform a plurality of types of image processing, including various types of image detection and image recognition, the apparatus comprising:

means for selecting between the plurality of types of image processing;

gradient calculation means for calculating at least the direction of the level gradient of each of a plurality of processing units in given image data including a plurality of pixels, the pixels respectively having level data;

line segment formation means for producing line segment image ~~data~~ representing a line segment which comprises a plurality of pixels for each of the plurality of processing units, each line segment having a given length and a direction corresponding respectively to the direction of each level gradient which is calculated by said gradient calculation means;

means for setting a line segment length associated with a type of image processing selected; and

line segment image storage means for storing the line segment image ~~data~~ produced by said line segment formation means.

60. (previously presented) The apparatus according to claim 59, further comprising means for selecting the direction corresponding to the direction of each level gradient.